
Space Weather Technical Forecast

Issued on Saturday, 22 July 2023 at 01:13 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales <https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales>

Space Weather Forecast Headline: Chance of R1/R2 throughout. Chance of Active fluence by Day 3 (24 July) or Day 4 (25 July).

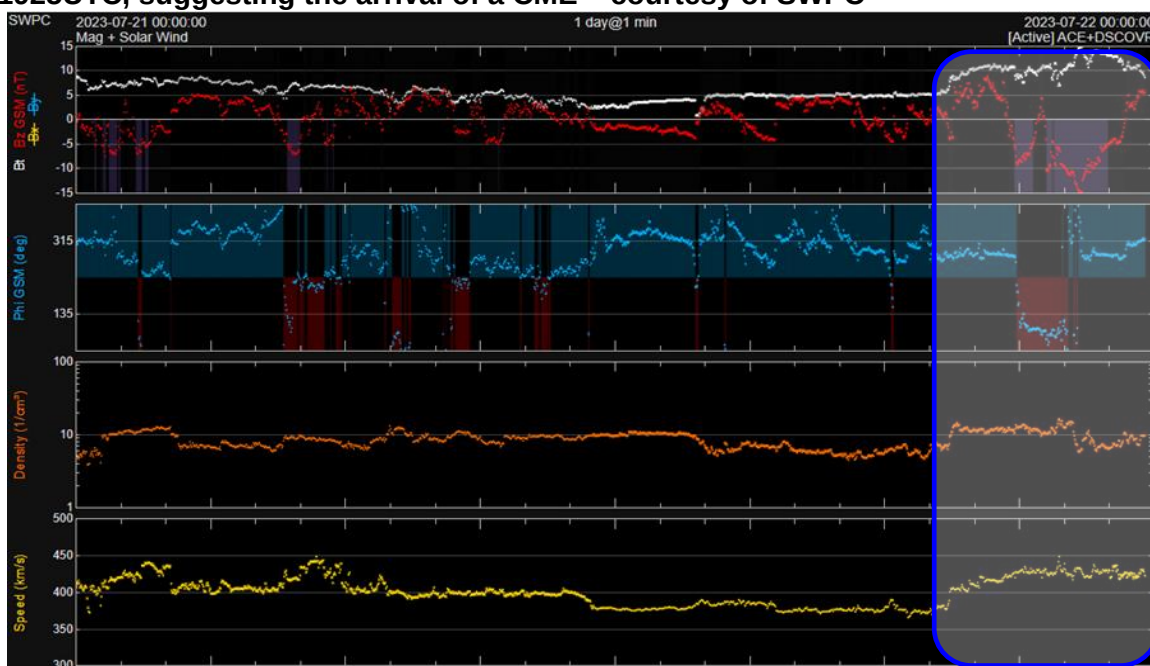
Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity has been Low over the past 24 hours, with only a few C2 flares originating from different regions. There are currently six sunspot regions on the solar disc. AR3373 remains the largest and most magnetically complex region. It has however lost its delta spot and has since been re-classified as Eai/Beta-Gamma. There are three other large regions, namely AR3372, AR3377 and AR3379.

No Earth-directed CMEs were observed in the available imagery.

Solar Wind / Geomagnetic Activity: Solar wind parameters, as measured by DSCOVR at L1, were indicative of a weak CME arrival at around 21/1925UTC. Solar wind speed jumped from 370 to 430km/s as the CME arrived. The density became slightly above average, peaking at 16ppcc at 21/2153 UTC. The IMF was weak but became moderate, reaching a peak of 14nT at 21/2222UTC. The Bz was varying between +/-6nT but became largely negative after the arrival, plummeting down to -14nT at 21/2222UTC. The phi angle was predominantly negative (towards the Sun). These resulted in geomagnetic activity being Quiet to Unsettled (Kp 0-3), with an Active (Kp 4) interval between 21/2100-2400 UTC.

Fig 0: Real time solar wind parameters showing a marked discontinuity around 21/1925UTC, suggesting the arrival of a CME – courtesy of SWPC



Issued by Met Office Space Weather Advisor, Tel: +44 (0) 330 135 4254 Email: moswoc@metoffice.gov.uk

Energetic Particles / Solar Radiation: The high energy (greater than 2MeV) electron flux remained between Low and Moderate levels, peaking at 361pfu at 21/1510UTC. The 24-hour integrated fluence fell sharply throughout the period, remaining well below the Active ($1e8$ integrated pfu) threshold. A fluence of $6.22e6$ pfu was recorded at 22/0000UTC. The high energy proton flux (greater than 10MeV), as observed by GOES16, was still declining after the recent S2 that occurred during the early hours of the 18th but eventually came back to background levels during the second half of the period. It remains slightly enhanced though.

Four-Day Space Weather Forecast Summary

Solar Activity: Solar activity is likely to be Low with a chance of an isolated M-class flare, mostly from AR3373 and AR3379.

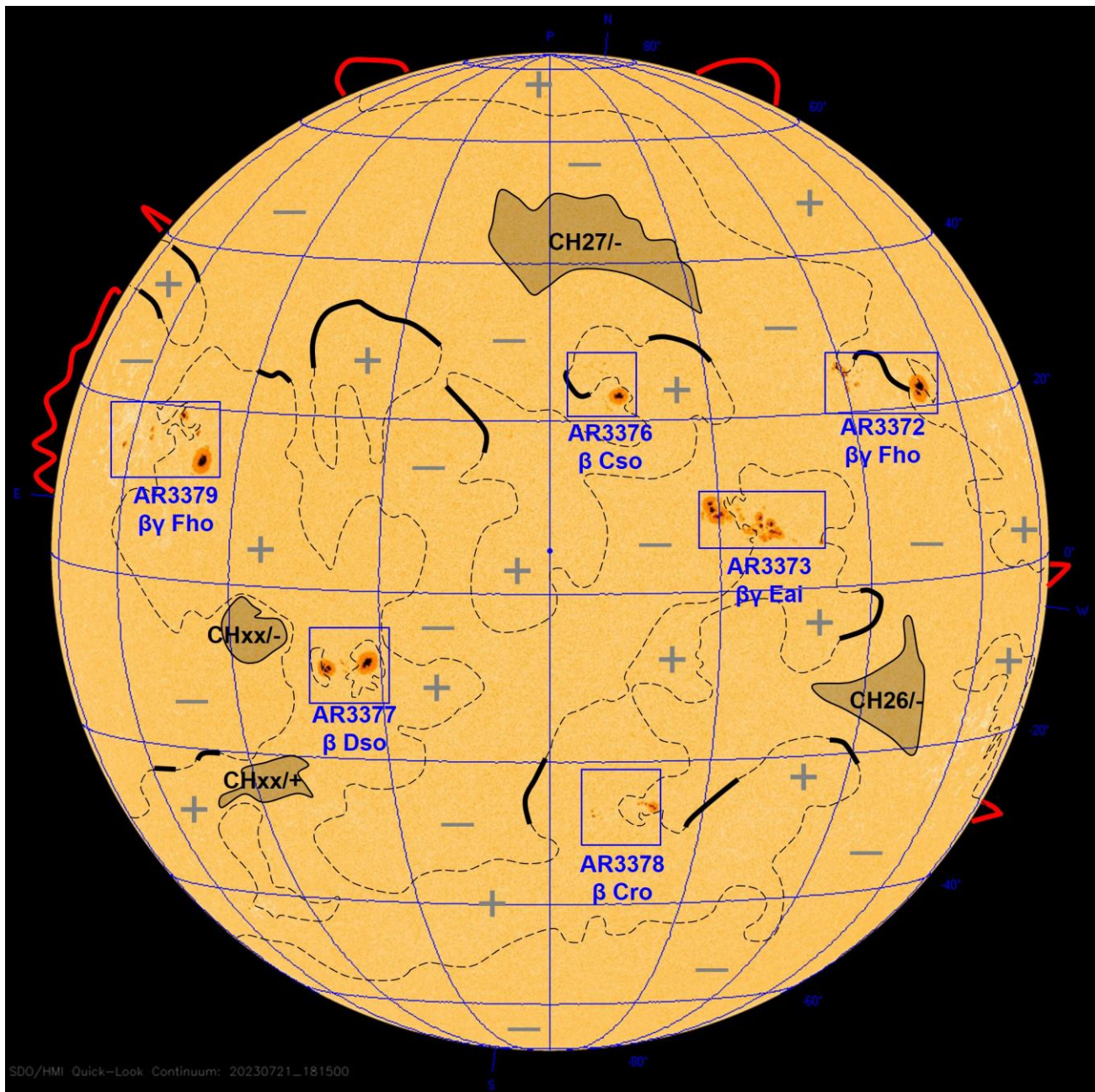
Solar Wind / Geomagnetic Activity: The CME that arrived at L1 around 21/1925UTC is expected to give minor impacts at Earth, with only a couple of Active intervals and perhaps a slight chance of a G1 (Minor Storm) interval in the early UTC hours of Day 1. Any influence from CH26/- is likely to be masked by the recent CME arrival but the HSS from CH27/- may connect with Earth on Day 3, with wind speeds of 450-500 km/s possible.

Overall, geomagnetic activity is expected to be Quiet to Unsettled for much of this period, with a chance of Active intervals on Day 1 (22 July) and at the end of Day 3 (24 July). A G1 (Minor Storm) interval is possible in the early UTC hours of Day 1.

Energetic Particles / Solar Radiation: The high energy electron flux (greater than 2MeV) is now at background levels, but is likely to increase, perhaps reaching high levels later in the period. There is a chance of reaching the Active ($1e8$ integrated pfu) threshold by Day 3 (24 July) or Day 4 (25 July).

The high energy (greater than 10MeV) proton flux is expected to continue to decline, reaching background levels, but with a slight chance of further increases should any larger flares occur. Later in the period there is a slight increase in the probability of S1 as AR3373 rotates further across the western hemisphere.

Figure 1. Solar Analysis Valid 21/2000UTC.



Key: Filament —, Prominence —, Magnetic Field Line - - -, Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

Geomagnetic Storms:

The CME that was observed leaving the Sun from the northeast around 18/2000UTC has arrived at L1 around 21/1925UTC. The impacts are still unfolding but given the modest increase observed in solar wind speed and density, the geomagnetic response is expected to be rather muted and may only lead to a couple of Active intervals, with perhaps a G1 (Minor Storm) interval in the early UTC hours of Day 1. No other Earth-directed CMEs currently feature in the forecast.

An influence from the small CH26/- (in the southern hemisphere) is possible, however any enhancement to the solar wind speed should remain modest and most likely masked by the recent CME arrival. A further enhancement from the HSS associated with CH27/- may occur later in the period, most likely on Day 3. However given its latitude, being far away from Earth, any enhancement should also be modest and limited in time. The latest Enlil suggests a flat trend and is considered to provide good guidance.

Overall, geomagnetic activity is expected to be Quiet to Unsettled for much of this period, with a chance of Active intervals on Day 1 (22 July) and at the end of Day 3 (24 July). A G1 (Minor Storm) interval is possible in the early UTC hours of Day 1.

Geo-Magnetic Storm	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Minor or Moderate	G1 to G2	No	20	1	5	1
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

NIL



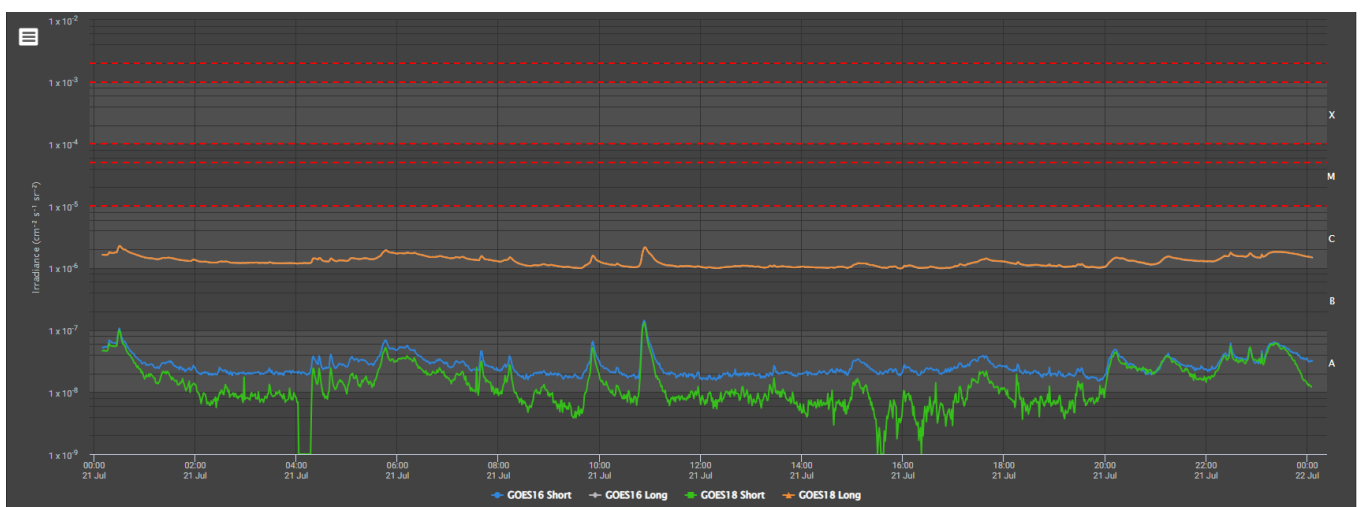
Radio Blackouts - X-Ray Flares:

Solar activity has been Low and declining over the past 24 hours, with only a few C2 flares originating from different regions. There are currently six sunspot regions on the solar disc. AR3373 remains the largest and most magnetically complex region. It has however lost its delta spot and has since been re-classified as Eai/Beta-Gamma. There are three other large regions, namely AR3372, AR3377 and AR3379. AR3372 has started to decrease in size and has lost a few sunspots on its trailing section. AR3377 seems unchanged and largely inactive. AR3379 consists of a large leading spot followed by an extensive open region which contains a couple of minor spots. It also appears largely inactive. The two other regions are small and decreasing in size.

Solar activity is likely to be Low with a chance of an isolated M-class flare, mostly from AR3373 and AR3379. Far side soundings suggest there are further regions to rotate onto the disc in the coming days, although these cannot be assessed until they become visible on the near side. In the absence of significant activity from over the limb, the probability of flaring is kept flat through this four day period.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	No	40	40	40	40
Very Active	R3 to R5 X Class	No	5	5	5	5

Figure 2: Latest X-ray flare activity, as observed by GOES-16



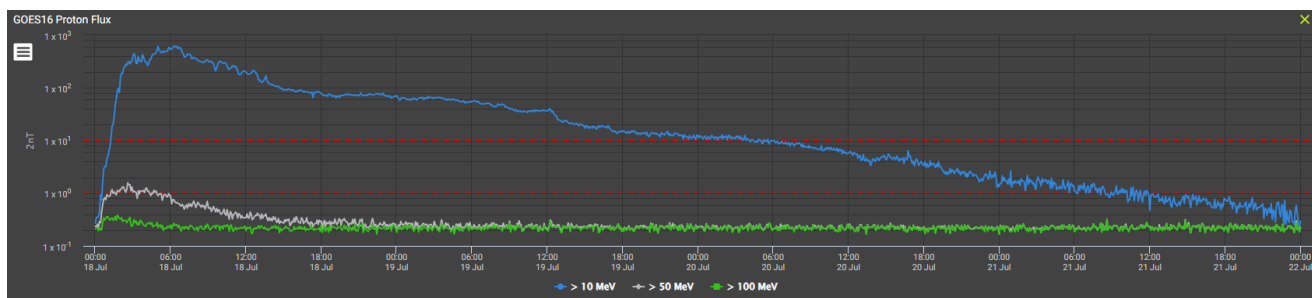
Solar Radiation Storms - (High Energy Protons):

The high energy (greater than 10MeV) proton flux, as observed by GOES-16, is now at background level, having previously reached a peak of S2 and 620pfu at 18/0620UTC. The chances of further such occurrences are now very slim as the region responsible continues to rotate further away from the west limb. However, with several large regions remaining on the visible disc and transiting westwards to a more favourable location, the risk is considered to persist throughout the period.

Radiation Storms	Level ($\text{cm}^{-2} \text{sr}^{-1} \text{s}^{-1}$)	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	$\geq \text{S1}$	No	5	5	5	5
Very Active	$\geq \text{S3}$ *	No	1	1	1	1

* $\text{S3} \geq 10 \text{ MeV} \geq 1000 \text{ pfu}$ and / or $\geq 50 \text{ MeV} \geq 10 \text{ pfu}$. (pfu = $\text{cm}^{-2}\text{sr}^{-1}\text{s}^{-1}$)

Figure 4: Proton flux observed at L1 over the last 4 days, showing the slow decline after the S2 proton storm that occurred on the 18th



High Energy Electrons Event ($\geq 2\text{MeV}$):

The high energy electron flux (greater than 2MeV) is now at background levels. The BAS radiation belt model suggests that some minor charging may have taken place in the radiation belts below GEO, however the recent arrival of a weak CME is likely to keep the flux suppressed in the short term. The flux will eventually rise and most likely reach high levels during the diurnal peak over the following days.

A similar pattern was observed on the last rotation, where the flux was able to reach 3000pfu on most days. However, with a lack of significant coronal hole high speed stream this time round, confidence is much lower and although the fluence is expected to show a rising trend overall, the corresponding fluence may not be able to reach the Active threshold ($1\text{e}8$ integrated pfu) before Day 3 or perhaps Day 4, especially if we consider how low it is currently.

The REFM is not in favour of this scenario and suggests a level trend. However it doesn't take into account the recent arrival of the CME and may provide poor guidance.

GEO Electron Environment	Level ($\text{cm}^{-2} \text{sr}^{-1} \text{day}^{-1}$)	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	$\geq 2 \text{ MeV}$ $\geq 1 \times 10^8$	No	20	40	50	60
Very Active	$\geq 2 \text{ MeV}$ $\geq 1 \times 10^9$	No	1	1	1	5

Figure 4: Electron flux observed during the previous rotation, as seen by GOES-16

